MA432: Linear Algebra

Fall 2023

Instructor:	Prashant Shekhar, PhD	**Email:**	shekharp@erau.edu
Class Time:	Tu,Th: 3:45PM – 5:00PM	**Class Venue:**	Bldg COAS Rm. 102
Office Hours (OH):	M,F: 1:00PM – 2:00PM	**OH Venue:**	Room 301.26, COAS.

Topics Included: Vector and matrix operations including matrix inverses, eigenvectors, and eigenvalues. Equations of lines and planes, vector spaces including basis and dimensions, linear transformations, change of basis, diagonalization of matrices, inner products and orthonormal bases, applications.

Why this course: The concepts that you learn in this course can be utilized to solve problems in applied mathematics and data sciences/machine learning. Some of the applications include: signal processing, computer vision, control theory, deep learning, computer animation and pattern recognition etc.

Text Book: *Linear Algebra and Its Applications* by David C. Lay, Steven R. Lay, and Judi J. McDonald, Sixth Edition, Published by Pearson

Attendance: I will take attendance in every class. I encourage you to participate in class activities because attendance is usually found to be heavily correlated with the course grade. Additionally, a portion of the course grade depends on class participation, making attendance very important. You are expected to be attentive to the Canvas site for any announcements, and to keep track of your grades.

Calculators: You can use a scientific calculator to work on in-class problems. Graphing calculators are not allowed on quizzes and tests.

Grading: Your grade will be determined as:

1. Homework: 25%
2. Quizzes: 15%
3. Tests: 30%
4. Final Project: 20%
5. Attendance/Class participation: 10%

The grading scale will follow the standard scale
A: 90% - 100%
B: 80% - 89.5%
C: 70% - 79.5%
D: 60% - 69.5%
F: <60%
However, based on class performance, I might curve the grading scale later.

Homework: Your homework grade is determined based on four homeworks. Apart from the homeworks, I will post a list of additional questions from your textbook. Please note that the additional questions will not be graded. You are expected to work on those questions to achieve proficiency in the material. **Please note that homeworks are only acceptable on canvas and not on email.** The course will implement the following late submission policy

- Late by less than 1 day, i.e. 24 hours (-20 points)
- Late between 1 day and 2 days (-40 points)
- Late between 2 day and 3 days (-60 points)
- Late between 3 day and 4 days (-80 points)
- Late by greater than 4 days (Not acceptable)

Quizzes and Tests: You will have 4 quizzes and 2 tests. Make-ups on any of these exams may be allowed only for valid extenuating circumstances when I am informed before the exam takes place – please see me about conflicts as soon as they occur. **In case you are missing an exam, it is your responsibility to schedule a makeup exam with me within one week of the actual exam date. After that makeup exam is not possible**.

Final Project: During the semester you will be supervised to work on a computer-based project which combines classroom materials and real-world applications. The project is the final classroom assignment. I will assign the project in the second half of the semester and you are expected to work individually on it. I will announce guidelines, and rubric in due course.

Academic Integrity: Embry-Riddle Aeronautical University maintains high standards of academic honesty and integrity in higher education. To preserve academic excellence and integrity, the University prohibits academic dishonesty in any form, including, but not limited to, cheating and plagiarism. More specific definitions of these violations and their consequences are described in the Dean of Students' Honor Codes and Student Policies.

Disability Services DSS Administration Office: Bldg 500; Contact: (386) 226-7916; email: dbdss@erau.edu
Testing Center: The Annex Building 2nd floor, room 217; Contact: (386) 226-2903; email: dbdss@erau.edu

- Student Disability Services: Students with disabilities who believe that they may need accommodations in this class are encouraged to contact the Office of Disability Services. Professors cannot make appropriate disability accommodations. Students are encouraged to register with DSS at the beginning of the term to better ensure that such accommodations are implemented in a timely fashion. Accommodations are not granted until official notice is received from DSS.
- DSS Testing Procedures: It is the responsibility of the student to notify DSS the date and time of test once s/he has been made aware of the scheduled test. DSS requires a 2 days minimum notification.

University policy for using AI programs: The use of ChatGPT and other artificial intelligence (AI) tools in an educational setting must be guided by ethical principles and academic integrity. Students and faculty may use these tools for research support or aids to enhance their learning and scholarship but should not rely solely on them to produce original work. The University recognizes the potential benefits of AI but acknowledges the potential risks, such as creating unauthentic, inaccurate, biased, or harmful content. Students should follow best practices to ensure authentic scholastic accomplishment and academic integrity, including avoiding plagiarism or machine ghostwriting. Ultimately, the University upholds the importance of intellectual honesty and ethical research practices and expects students to act in accordance with these principles when using AI tools.

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Tentative Schedule for Fall 2023

SNo: Week of (class days)	*Section*	*Topics*	*Homework*	*Learning Outcome*
1: 28^{th} Aug (Tu,Th)	1.1 1.2	Systems of Linear Equations Row Reduction and Echelon Forms		1 1
2: 4^{th} Sept (Tu,Th)	1.3 1.4	Vector Equations Matrix Equation: Ax=b Quiz 1		2,3 1,3
3: 11^{th} Sept (Tu,Th)	1.5 1.7	Solution set of linear systems Linear Independence	HW1 released	1,3,12 5
4: 18^{th} Sept (Tu,Th)	2.1 1.8	Matrix Operations Introduction to linear transformations Quiz 2		2 6
5: 25^{th} Sept (Tu,Th)	1.9 2.2 2.3	Matrix of Linear Transformations Inverse of a matrix Characterizations of Invertible Matrices	HW1 due HW2 released	6,7,12 1,12 8,12
6: 2^{rd} Oct (Tu,Th)	2.5	Matrix Factorizations Test 1 review Test 1		1,8,11,12
7: 9^{th} Oct (Tu,Thu)	 2.8 4.1	No Lecture (10^{th} Oct) Subspaces of $\mathbf{R}^n$ Vector Spaces and Subspaces	 HW2 due	 2,4,5 2,4,5
8: 16^{th} Oct (Tu,Th)	4.2	Null Spaces, Column Spaces, Row Spaces, and Linear Transformations Quiz 3 No Lecture (19^{th} Oct)	HW3 released	2,4,5,7,8
9: 23^{th} Oct (Tu,Th)	2.9 4.3	Dimension and Rank Linearly Independent Sets; Bases		4,5,8 4,5,8
10: 30^{st} Oct (Tu,Th)		Project Day I Project Day II	 HW3 due	12 12
11: 6^{th} Nov (Tu,Th)	3.1 3.2 5.1	Introduction to Determinants Properties of Determinants Eigenvectors and Eigenvalues	HW4 released Project released	1,9 1,9 9
12: 13^{th} Nov (Tu,Th)	5.2 5.3	The Characteristic Equation Quiz 4 Diagonalization		9 7,9,11,12
13: 20^{th} Nov (Tu, Th)	6.1	Inner Product, Length, and Orthogonality No Lecture (23^{rd} Nov)	HW4 due	10
14: 27^{th} Nov (Tu,Th)	6.2 6.4	Orthogonal Sets The Gram-Schmidt Process Test 2 Review		10 10,11
15: 4^{th} Dec (Tu,Th)		Test 2 Questions ?	 Project due	

Learning outcome: After successful completion of this course, you will acquire knowledge to:

1. Use Gaussian Elimination to solve systems of linear equations or to calculate matrix inverses.
2. Perform vector and matrix operations such as addition and multiplication.
3. Calculate equations of planes and lines in three dimensions.
4. Use the definition of vector spaces to identify vector spaces and subspaces.
5. Test set of vectors for linear independence and calculate bases for given vector spaces.
6. Calculate matrices representing linear transforms such as projections, reflections, and rotations.
7. Use similarity transforms to calculate matrix representations of linear transforms when a new basis is selected.
8. Use matrices to solve linear homogeneous and nonhomogeneous equations and relate the rank and nullity of the matrices to the linear equations.
9. Calculate a basis of eigenvectors so that a linear transformation is represented by a diagonal matrix.
10. Use the definition of inner product in a variety of vector spaces and use Gram-Schmidt process to construct an orthonormal basis for a vector space.
11. Identify orthogonal matrices and symmetric matrices and utilize their properties for matrix decompositions.
12. Apply the concepts learned in the course to solve real-world problems.